Notes and News

1st Mrinal Kanti Dewanjee Award Ceremony

The first Mrinal Kanti Dewanjee Award Ceremony of presenting three Lifetime Achievement Awards and two Student Awards conducted by Indian Science News Association (ISNA) was held on 29th January 2018 at the Auditorium of Bose Institute, Kolkata.

Dr. T. Ramasami, Former Secretary, Department of Science & Technology, Govt. of India was the Chief Guest of the occasion. Professor Sunil Kumar Talapatra, Vice-President, ISNA, presided over the meeting in absence of Dr. K. Muraleedharan, President, ISNA and Director, CSIR-CGCRI, Kolkata.

Professor Sudhendu Mandal, Honorary Secretary, ISNA felicitated Dr. T. Ramasami with an *Uttoriyo* and a copy of the book entitled "Sir P.C. Ray, the Father of Chemistry Teaching and Research in India, a Philanthropist and an Entrepreneur" published by ISNA on the 150th Birth Anniversary of Sir P.C. Ray. Another book entitled "D.M. Bose: A Scientist Incognito" written by Professor Suprakash Chandra Roy and Dr. Rajinder Singh, published by Bose Institute as a part of their Centenary Programme was also presented to him. Professor Talapatra was also felicitated by an *Uttoriyo* and a flower bouquet.

In his speech Dr. T. Ramasami said about the rich tradition of science being pursued in Kolkata reminding us about the legendary contribution of J.C. Bose made in physics and plant science. He said it is always a different kind of feeling every time he visits Bose Institute.

Professor Sudhendu Mandal, Honorary Secretary, ISNA in his welcome address mentioned that the Lifetime Achievement Award (LAA) for Scientific Research and Students' Award (SA) for Basic Science Research were instituted by the generous donation received from Professor Mrinal Kanti Dewanjee, a Guest Scientist at National Institutes of Health, USA.

This year the recipients for LAA were nominated by Dr. Mrinal Kanti Dewanjee, which were then approved by the Council of ISNA.The three awardees of this year are Dr. Devi Prasad Shetty, Professor Parimal Chandra Sen and Professor Suprakash Chandra Roy.

Professor Sudhendu Mandal then introduced the three awardees one by one to the audience. LAA is being conferred on Dr. Devi Shetty, a renowned cardiologist, for his pioneering work and tremendous service as a cardiac surgeon. He is the founder of Narayana Hrudayalaya Private Limited, Bangalore and Rabindranath Tagore International Institute of Cardiac Sciences (RTIICS) in Kolkata. He has received a large number of national and international awards including Padma Shri in 2004. Unfortunately, Dr. Shetty could not make himself available in today's event because of his other commitments but he has assured to visit ISNA sometimes in future and would receive the award in person.

LAA is being conferred on Prof. Parimal Chandra Sen (FNASc, WBAST), Senior Professor and National Academy of Science (India) Platinum Jubilee Senior Scientist at Bose Institute, for his pioneering work on ion transporting enzymes and their role in different disease processes with special reference to the study of low molecular weight synthetic compounds for the development of anticancer agent(s) based on cell culture, animal and human experiments targeting SERCA (Serco-endoplasmic Reticulum Ca- ATPase). He is also a recipient of a number of awards at national level and is in the editorial board of several international journals.

Figure 1: Prof. Parimal Chandra Sen (extreme right) receiving Lifetime Achievement Award from Dr. T. Ramasami, Former Secretary, DST, Govt. of India (second from the left). Also present are (from the left) Prof. Biswapati Mukherjee, Prof. Sunil Kumar Talapatra and Prof. Sudhendu Mandal.

Professor Mandal introduced Professor Suprakash Chandra Roy as a reputed radiation physicist who was

Figure 2: Prof. Suprakash Chandra Roy (extreme right) receiving Lifetime Achievement Award from Dr. T. Ramasami, Former Secretary, DST, Govt. of India (second from the left). Also present are (from the left) Prof. Biswapati Mukherjee, Prof. Sunil Kumar Talapatra and Prof. Sudhendu Mandal.

Professor and Chairman of the Department of Physics at Bose Institute. LAA is being conferred on him for his outstanding work in translating the physics of vapour nucleation to developing gamma insensitive neutron detector to measure neutron dose. This detector known as Superheated Drop Detector (SDD) finds its practical application in treating patients for radiotherapy using high energy gamma rays. Professor Mandal also mentioned that in addition to his scientific works, Professor Roy is a prolific writer and is working as the Editor-in-Chief of the journal Science and Culture, the mouthpiece of ISNA, for about 15 years now. He has authored two books. One of his books titled "D. M. Bose : A Scientist Incognito" has been recently published by Bose Institute as a part of its centenary celebration was released on 30th November 2017. Professor Roy is also a Member of the National Commission of History of Science, Indian National Science Academy (INSA), an honour received by an editor of Science and Culture only after D.M. Bose.

Professor Sudhendu Mandal remarkably mentioned that it is a great coincidence that the two scientists who are receiving this award today spent major part of their scientific career at Bose Institute and are being honoured in the centenary year of the same institute.

Professor Parimal Chandra Sen and Prof. Suprakash Chandra Roy presented their Award Lectures. The topic of Professor Parimal Chandra Sen's lecture was "Nifetepimine a dihydropyrimidone couples the cross-talk between the ER Stress and MERKERK pathway to induce apoptosis in human triple-negative breast cancer (TNBC) cells". Prof. Suprakash Chandra Roy delivered a lecture on "Translational research in developing a neutron detector used in radiation treatment in patients".

Dr. T. Ramasami presented the Lifetime Achievement award to Professor Parimal Chandra Sen and Professor Suprakash Chandra Roy. The award consists of a silver plaque, a certificate and a cheque of Rs.25,000/-.

Figure 3: Ms. Ayantika Paul (third from left) receiving Students' Award for Basic Science Research from Prof. Sunil Kumar Talapatra, Vice-President, ISNA (fourth from left). Also present (from left) Prof. Biswapati Mukherjee, Dr. T. Ramasami and Prof. Sudhendu Mandal (extreme right).

The second session of the programme was Students' Award for Basic Science Research. This award is meant for students of Class XI – XII. Two awards one in Physical Science and other in Life Sciences were given. The recipients were selected on the basis of their write-updescribing the importance of basic science research including translational research and their impact on society. Final selection was made on the basis of audio-visual presentation by the candidates evaluated by a panel of experts appointed by the Council of ISNA. Shri Kuntal

Figure 4: Shri Kuntal Acharya (second from left) receiving Students' Award for Basic Science Research from from Prof. Sunil Kumar Talapatra, Vice-President, ISNA (third from left). Also present Dr. T. Ramasami (extreme left) and Prof. Sudhendu Mandal (extreme right).

Acharya of Gangnapur High School, Nadia received the award for physical science and Ms. Ayantika Paul of Garalgacha High School, Hooghly for life science. Each award consists of a cash prize of Rs. 10,000/ - , a medal and a certificate was presented by Prof. Sunil Kumar Talapatra, Vice-President of ISNA.

The vote of thanks was proposed by Professor Biswapati Mukherjee. ❐

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Super Blue Blood Moon

After a long period of more than 150 years, our 'Blue Planet' has observed 'super blue blood moon' on the 31st January, 2018, a splendid celestial spectacle, last seen on the 31st March,1866 and the previous one on the 31st May, 1844. According to a tweet of NASA, next 'super blue blood moon' will happen on January 31, 2037.

Now I would explain 'super moon', 'blue moon', 'super blood moon' and finally 'super blue blood moon'. When the moon comes closest to the earth in its elliptical orbit, it is said that the moon is in 'perigee position' and if it so happens that in perigee position, the phase of the moon is 'full moon', then we term it 'super moon' and incidentally if on that 'full moon'-day, total lunar eclipse occurs, the term changes to 'super blood moon'.

Fig.1. The blue moon of 31st January 2018

Before explaining addition of the word 'blood', I would explain what happens when total lunar eclipse occurs.

During total lunar eclipse, the moon remains in the umbral cone of the earth and hence light from the sun does not enter into the surface of the moon and as such it should have been invisible in the sky. But the fact is - the eclipsed moon looks like a coppery red disc.

What is the cause behind? Actually, the rays from the sun bend into surface of the shadowed moon because of refraction by the atmosphere surrounding the earth and we know, red and orange colour of white light are less scattered compared to other colours like violet and blue. So, due to red and orange colours, the moon appears to be blood-red and hence it is termed 'blood moon'. Had there been no atmosphere in the earth, the eclipsed moon must have disappeared from the sky.

Incidentally, if it happens that during total lunar eclipse, the moon remains in the perigee position, it is called 'super blood moon'. Now, what is 'blue moon'? The term 'blue' is not associated with blue colour at all. Actually, what happens, if two 'full moon'-days are accommodated in one calendar-month, then the 2nd 'full moon' is termed 'blue moon'.

It's rare because of the fact that the time-span between two successive 'full moon'-days is 29.6 days and hence in order that two 'full moon'-days are covered by one calendar-month, February even in lip years is an impossible month and in case of other months, the possibility is obviously rare and the rarest possibility among rare possibilities is 'super blue blood moon'. The 31st January, 2018 was such a day, rarest of rare 'blue moon'-days, when the moon was in the perigee position during total lunar eclipse. Our beloved 'city of joy' Kolkata observed (see Fig. 1) such a beautiful celestial spectacle during the period of 1 hour and 16 minutes from 18:21:27 IST to 19:37:51 IST.

Had it been the case that an astronaut stayed on the surface of the eclipsed moon, he must have seen and enjoyed a more beautiful celestial spectacle, i.e., fabulous total solar eclipse for the same period of 1 hour and 16 minutes' duration, while in the beginning and at the end of eclipse, mind-blowing 'DIAMOND RINGS' must have appeared and during totality, 'CORONA' could not have been seen, because, the earth remaining in between the sun and the moon has made obscure not only 'PHOTOSPHERE' but also 'CORONA' due to its large size and instead, a beautiful coppery red bangle seen round the 'solar disc' during the entire period of totality.

In this context, it is to be mentioned that while 31stJanuary, 2018 was a 'full moon'-day in the earth,the

same day was definitely a 'new earth'-day in respect of the moon, i.e. the earth was invisible from the surface of the moon on that day. ❐

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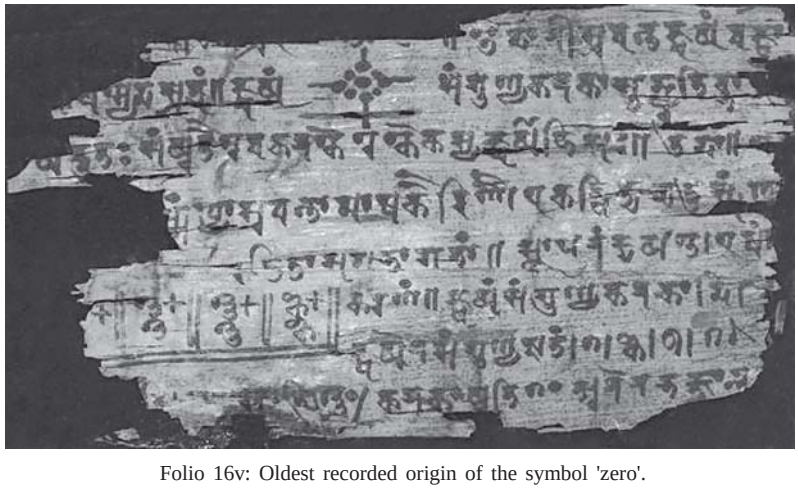
Illuminating India: Celebration of UK-India Ties

UK/India 2017 inaugurated on October 3, 2017 'Illuminating India', a six month-long celebration of the long standing relation between India and the U.K. It comprises two major exhibitions – '*5000 Years of Science and Innovation'* and '*Photography 1857–2017'* at the Science Museum at Exhibition Road, South Kensington, London. While the former reveals a kaleidoscopic history of scientific breakthroughs in India, the latter highlights the development of photography in India - both from the beginning to the present day. The celebration has been open to the public from Wednesday, the 4th October, 2017 and will continue till Saturday, the 31st March, 2018 from 10.00-18.00 Hrs on weekdays and from 10.00-19.00 Hrs on school holidays.

The British Council has arranged for this programme in partnership with the Bagri Foundation and with support from the Helen Hamlyn Trust and the John S. Cohen Foundation. The Bagri Foundation is a U.K.-based charitable organisation working in the fields of education, relief work and culture. It collaborates with 'leading organisations, scholars and artists to encourage critical thinking, disseminate knowledge and offer platforms for creativity to blossom'. The celebrations were slated to mark 70 years of India's independence.

A series of diverse events including film screenings, workshops, panel discussions, live performances, etc. have been arranged during the entire period of the celebration. The events highlight the scientific and cultural fabric of India. Some of them are (i) a Symposium (Oct. 6, 2017) on India's Place in Photography's World, (ii) Screenings of the Oscar-winning film 'Slumdog Millionaire' (Oct. 27, 2017) and of 'The Man Who Knew Infinity', the biopic of Srinivasa Ramanujan, FRS (Feb. 16, 2018), (iii) Conversations with Sadhguru, New York Times best-selling author on the co-existence of science and spirituality (Nov. 13, 2017) and with Moumita Dutta, Project Manager, Mangalyaan Mars Orbiter Mission, ISRO (Nov. 29, 2017), (iv) Performance (Nov. 24, 26, 2017) of 'Sriyah', a form of Odissi dance, by Bangalore-based 'Nrityagram', (v) Family Weekends (Nov. 25-26, 2017 and Jan. 27-28, 2018) with diverse Indian cultural programmes and (vi) a Panel Discussion (Feb. 3, 2018) between three experts in Indian science, technology and innovation with the Curatorial Team of Illuminating India.

The exhibition *5000 Years of Science and Innovation* displays information and documents on high-impact discoveries in the fields of mathematics, plant science, space exploration, communication and engineering. Some of the notable exhibits are (i) Stone Weights used in the Indus Valley Civilisation (*ca.* 3000 BC), (ii) the Bakhshali manuscript (70 pp.) (224-383 CE) containing the oldest record of the use of Zero as a numeral, (iii) 'Bhugola' or 'Earth Ball' (India; 1571) made from brass and with two views (traditional Hindu view and Ptolemaic idea) of the world map depicted on its outer surface, (iv) Oscillating Plate Phytograph (Sir Jagadish Chandra Bose; early 1900s), (v) a Spectrometer (Sir C.V. Raman, N.L.; 1928), (vi) Jaipur Foot prosthesis (R.C. Sharma and Dr. P.K. Sethi; 1968), (vii) USB Connector (Ajay Bhatt, Intel; 1994), (viii) Intel Pentium Processor (Vinod Dham, 'Father of The Pentium Chip') and (ix) 'Tuk-Tuk', a hybrid of Cycle Rickshaw and Electric Scooter.



Folio 16v: Oldest recorded origin of the symbol 'zero'.

The correspondence and writings of important personalities are also kept there in the exhibition. These include (i) letters from Professor S.N. Bose to Albert Einstein, held by the Hebrew University of Jerusalem, Israel, (ii) selected papers of S. Ramanujan, held by Trinity College, Cambridge, (iii) an Index Chart of the Trigonometrical Survey

of India which "*no map in the world at that time could rival*" for scale detail and accuracy, etc.

Pivoting on two key years – 1857 (Sepoy Mutiny) and 1947 (Independence of India) - the exhibition '*Photography 1857-2017*' attempts to survey the technological and artistic development of photography in India. Early works by Indian photographers and their foreign counterparts since the 1850s are presented in this Exhibition. Photographs focussed around 1857 include works by Ahmad Ali Khan (court photographer to the last King of Lucknow) to Felice Beato. Those focussing around 1947 include works by Magnum artists like Henri Cartier-Bresson (Magnum co-founder), Late Werner Bischof, Olivia Arthur and Sohrab Hura. Other notable artists include Maharaja Sawai Ram Singh II (pioneer of Indian art photography), Vasantha Yogananthan (award-winning Indian photographer) and Homai Vyarawalla (first female photojournalist). In fact, the stepwise development of the photographic medium – from the very first fragile salt prints to the latest digital imagery – has been put on display.

Pertinently, the conspicuous absence of many glaring examples of achievements in both scientific and photographic developments in India is, at the best, inexplicable. ❐

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Largest Prime Number: $2^{77,232,917}-1$

Jonathan Pace, a 51-year old Electrical Engineer from Germantown, Tennessee, USA discovered on the 26th December, 2017 that **$2^{77,232,917}-1$** is a **new Prime Number** having the largest ever number of digits – over 23 million, actually 23,249,425 digits. Pace has been searching for new primes for over 14 years, which finally paid off. The new prime has been named **M77232917** where the letter M indicates that it is a Mersenne prime number. It took Pace six days of non-stop computing on a computer with Intel i5-6600 CPU to verify that it is a prime number. The finding was independently verified using four different programmes on four different hardware configurations by Aaron Blosser (Prime95; Intel Xenon server; 37 hrs), David Stanfill (gpuOwL; AMD RX Vega 64 GPU; 34 hrs), Andreas Höglund (CUDALucas; NVidia Titan Black GPU; 73 hrs) and Ernst Mayer (Mlucas; 32-core Xenon AWS instance; 82 hrs). Pace has been eligible for a cash reward of $ 3,000 from GIMPS (Great Internet Mersenne Prime Search) for this discovery. However, the official credit for it goes to 'J. Pace, G. Woltman, S. Kurowski, A. Blosser *et al.*' since Pace ran the Prime95 software, Woltman wrote the software, Kurowski and Blosser worked on the Primenet server and thousands of GIMPS volunteers sifted through millions of non-prime candidates.

Three things need to be clarified at this stage – Prime Number, Mersenne Prime and GIMPS. An integer that is divisible only by one (1) and itself is called a Prime Number. The first prime numbers are 2, 3, 5, 7, 11, etc. The importance of prime numbers stems from the fact that many forms of cryptography algorithms, the form of mathematics that makes the internet a secure system, were developed from prime numbers.

A Mersenne prime is a prime number that is one less than a power of two, i.e. conforming to the formula 2^P-1, where P is a prime number. Accordingly, the first few Mersenne primes are 3, 7, 31, 127, etc. corresponding to P = 2, 3, 5, 7, respectively. The present Mersenne prime is the 50th one. Although first discussed by Euclid about 350 BC, Mersenne primes bear the name of the French monk, Marin Mersenne (1588-1648) who made a famous conjecture on which values of P would yield a prime. But three centuries elapsed and several mathematical discoveries were made before this conjecture could be verified. Pertinently, the newfound Mersenne prime is larger by one million digits than the previous largest Mersenne prime discovered towards the end of 2015 which, in turn, was five million digits larger than the one discovered before it in 2013. It is not predictable as to how often the Mersenne primes would be found and what would be the difference between two consecutive Mersenne primes. For record, amongst the last 15 discoveries (excluding the latest one) of the Mersenne primes, nine were discovered in USA, two in Germany and one each in Norway, Canada, UK and France. In this list, the closest gap between two successive discoveries of Mersenne primes was only one month - the 45th and the 46th Mersenne primes being discovered in August, 2008 (USA) and September, 2008 (Germany), respectively.

The GIMPS was formed in January, 1996 by George Woltman, a co-discoverer of the new Mersenne prime, in order to find new record size Mesenne primes. In 1997, Scott Kurowski, also a co-discoverer, 'enabled GIMPS to automatically harness the power of thousands of ordinary computers to search for these *needles in a haystack*'. It is registered as a 501©(3) science research charity organisation. Clearly, most of the GIMPS members join

this search merely for the thrill of discovering record-setting, rare and historic new Mersenne prime numbers. Anyone with a powerful PC can join GIMPS, possibly grabbing a cash reward. The necessary software can be downloaded for free from *www.mersenne.org/download/*. Additional information on GIMPS is available at *www.mersenneforum.org* and at *www.mersenne.org.*

The history of the development of the arithmetic algorithms underlying the GIMPS is quite interesting. Late Richard Crandall, a distinguished Scientist of Apple, discovered in 1990s ways to double the speed of convolutions which are essentially big multiplication operations. He also patented the Fast Elliptic Encryption system which uses Mersenne primes to quickly encrypt and decrypt messages. Woltman, referred to earlier, implemented Crandall's algorithm in assembly language. These discoveries led to the development of a search programme (for Mersenne prime numbers) of unprecedented efficiency. Thus the GIMPS cropped up.

Mersenne primes have got connection with what are known as perfect numbers. A perfect number is one whose divisors add up to the number itself. Thus, the smallest perfect number is 6 = 1 + 2 + 3. The second perfect number is 28 = 1 +2 + 4 + 7 + 14. Euclid had proven that every Mersenne prime generates a perfect number. Also, Euler (1707-1783) had proven that all even perfect numbers come from Mersenne primes. The newly discovered perfect number is thus $2^{77,232,916}$ x ($2^{77,232,917}$-1). Please do not try to calculate because it is more than 46 million digits long. It is as yet not known if any odd perfect number exists.

GIMPS will continue to hunt for newer Mersenne primes. The Electronic Frontier Foundation has announced a reward of $ 1,50,000 for finding a prime 100 million digits long. Let's see who grabs it. ❐

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Superionic Ice – A Strange, New State of Matter

Monday, the 5th February, 2018 witnessed the publication of the creation of 'Superionic Ice', also called 'Superionic Water', alleged to be a weird cross between liquid water and solid ice and having the property of conducting electricity. The work was published in *Nature Physics* (doi:10.1038/s41567-017-0017-4) by the team of Marius Millot, a physicist at Lawrence Livermore National Laboratory, California, USA. According to him "*That's really a strange state of matter*." In the words of Raymond Jeanloz, also an author of the aforesaid paper and a Professor of Earth and Planetary Science, University of California, Berkeley, "*It's as though the water ice is partially molten*." To understand the new findings, one needs to understand what ice VII is. Here it is.

In ordinary water, a molecule containing two hydrogen atoms attached to one oxygen atom is V-shaped. In the usual ice (known as ice I_h as per the Bridgman nomenclature), the V-shaped molecules connect in an airy structure, which explains why water, unlike most other liquids, expands when it freezes. However, when the water molecules are somehow squeezed enough, the hydrogen and oxygen atoms may be stacked in other crystalline structures. In fact, in addition to ordinary water ice, different forms of ice, from ice II to ice XVI, have been created in the laboratory at different temperatures and pressures. Ice VII, utilised in the preparation of superionic ice, is a cubic crystalline form of ice that can be formed from liquid water within nanoseconds by rapid compression (3 GigaPascals, i.e. 30,000 Atms) *via* shock-waves by lowering its temperature to room temperature. Ice VII has a density of *ca.* 1.65 g/cc (at 2.5 GPa, 25°C) – nearly 60% denser than ordinary water. Pertinently, ice VII is the only disordered phase of ice that can be ordered by simple cooling.

In the present work, the scientists squeezed water between two pieces of diamond anvil cell under a pressure of 2.5 GPa, i.e. nearly 25,000 times greater than the air pressure on the surface of the earth when ice VII was formed. Each diamond cell contained about 1-7 millionth of an ounce of water. This compressed ice, packed in carry-on luggage, was taken to the University of Rochester and blasted by a pulse of LASER. It caused shock waves through the ice, which lasted 10-20 billionths of a second, heating it to thousands of degrees and exerting a pressure more than a million times that of earth's atmosphere. The resulting mass was not shiny or reflective, which indicated that electrons were not moving around inside it. Instead, it was opaque, which pointed to the movement of ions (and not electrons) inside it – a Superionic Ice was created!

As early as 1988 theorists had suggested that superionic ice might exist under high pressures and at high temperatures. While the heat 'melts' the chemical bonds between the hydrogen and oxygen atoms, the high pressure pushes the heavier oxygen atoms to a fixed crystalline shape. The net result would be a solid formed from stacked oxygen atoms, through which the hydrogen ions flow as a

liquid. Thus the superionic water or ice should be a conductor of electricity (like metals), but the current is carried by positively charged hydrogen ions instead of by electrons observed in the case of metals. Many scientists had earlier obtained indirect signatures for superionic ice, but no one could prove it experimentally until the present report.

Using time-resolved optical pyrometry and ultrafast LASER velocimetry measurements, supported by DFT-Molecular Density simulations, Millot *et al.* unravelled the thermodynamic signature of superionic ice during the brief 10-20 nanosecond duration of the experiment. The results showed that this matter melts near 5,000 K (almost the surface temperature of Sun) at 190 GPa. Also, optical reflectivity and absorption measurements demonstrated the low electronic conductivity of this ice. Millot said, "*Our experiments have verified the two main predictions for Superionic Ice – very high protonic/ionic conductivity within the solid and high melting point*." These scientists spent two years making the measurements and two more years developing methods to analyse the data.

This discovery has important implications in planetary science. It is believed that Superionic Ice may form the ocean floor of Titan and extrasolar planets like Gliese 436 b and Gliese 1214 b that are largely made of water. More importantly, superionic ice could help explain the lopsided, off-center magnetic fields of Uranus and Neptune (known as icy giants). In contrast to earth's magnetic field being generated at the core of earth, the magnetic fields of the icy Uranus and Neptune may originate partly within superionic ice shells inside their mantles.

Finally, one Dr. Car who explored superionic ice in computer simulations, suggested that there may be several types of superionic ice, with oxygen atoms locked at different crystal structures at still higher pressures. However, it remains to be verified. In the meantime, welcome to the dawn of Superionic Ice era. ❐

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Demise of Professor Stephen William Hawking

Stephen Hawking, an icon of science, died on14th March, 2018 at his home in Cambridge, UK at the age of 76 years. Hawking was born on January 8, 1942 in Oxford.

In 1959, his parents moved from London to St Albans, Hertfordshire to escape German bombing. Hawking attended St Albans School. "*Physics and astronomy offered the hope of understanding where we came from and why we are here. I wanted to fathom the depths of the Universe*," recalled Hawking.

He got a scholarship, studied Natural Science in the University College, Oxford and graduated with a 1st class Honours degree in Physics. In 1962, he started doctoral research at the Department of Applied Mathematics and Theoretical Physics, Trinity College, Cambridge and earned the Ph.D. degree. He then became a Research Fellow at Gonville and Caius College, Cambridge. In 1979, he became the Lucasian Chair of Natural Philosophy. In 2009, he retired and was appointed Director of Research in the Department of Applied Mathematics and Theoretical Physics – a position he held until his death.

Hawking's personal life was very sad indeed. Shortly after his 21st birthday, Hawking was diagnosed to suffer from ALS (Amyotrophic Lateral Sclerosis), in which motor neurons die and leave the brain incapable of controlling muscles. His physical condition started deteriorating rapidly, and he had to be confined to wheelchair ever since. In 1985, Hawking contracted pneumonia when he was in Switzerland. To save his life, tracheotomy was done. Since then he was able to speak only through a computer-controlled voice synthesiser. Hawking married Jane Wilde in 1965, and the couple had three children – Robert, Lucy and Timothy. Shockingly, Hawking divorced Jane in 1995 and married Elaine Mason, one of his nurses, in the same year but divorced her in 2007.

Stephen Hawking is best known for his contribution in the field of Black Holes. When massive stars collapse under their own gravity into infinitesimal points, 'black holes' are created. In the 'event horizon' of the black hole, an extremely intense gravitational field is left behind. This field is so strong that nothing, not even light, can escape it; everything would appear completely black. Hawking reasoned in 1974 that quantum mechanics would allow a black hole to radiate energy slowly back into space. This suggested flux of particles from a black hole into space came to be known as Hawking radiation. In 2002, Dr. Hawking said he wanted the formula for Hawking radiation to be engraved on his tombstone.

Unfortunately, Hawking radiation could not be detected as yet. Perhaps for this reason Hawking did not receive the Nobel Prize. Nevertheless, his work got recognised, and he bagged many awards including the prestigious Copley Medal of the Royal Society, the Albert Einstein Award and many more. He was, *inter alia*, a Fellow of both the Royal Society and the US National Academy of Sciences.

He wrote many books on science and a number of books to popularise science. The first of the latter, *A Brief History of Time* (1988) was a layman's guide to cosmology. It remained a Sunday Times best-seller for a record-breaking 237 weeks. A film '*The Theory of Everything*', based on Hawking's first wife's account of their courtship and marriage, was released in 2014. It made worldwide acclaim. Hawking enjoyed making cameo appearances on some television shows. He liked to travel. He visited even Antarctica (1997) and experienced (2007) weightlessness in a zero-gravity flight (routine for astronauts).

Stephen hawking will always be remembered as a Cosmologist, as a populariser of science and as a symbol of triumph of mind over body. ❐

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Richard E Taylor Who Helped Discover Quarks Died at the Age of 88

Richard E Taylor who won 1990 Nobel Prize in Physics jointly with Jerome Friedman and Henry Kendall "for their pioneering investigations concerning deep inelastic scattering of electrons and protons and bound neutrons, which have been of essential importance for the development of quark model in particle physics" died on February 22, 2018 at the age of 88. His experiments helped to demonstrate the existence of quarks, more fundamental than protons and neutrons that are commonly known as the ultimate constituents of matter.

Taylor was born on November 2, 1929 in the town of Medicine Hat in the province of Alberta in Canada. After obtaining undergraduate and master's degrees at the University of Alberta, he joined Stanford and obtained his Ph.D. Degree in 1962 with a brief stint at a linear accelerator laboratory in Paris and at Berkley.

The simplest model of an atom is that there is a nucleus which contains protons and neutrons (nucleons) surrounded by electrons. These are considered to be the elementary or fundamental particles, assuming that they are the ultimate subunits of an atom. However, scientists were curious to know whether nucleons can be further subdivided. In order to understand this scientists realized that they need high energy electron beam targeted to the nucleons to shatter them. Fortunately, Stanford built an accelerator which is known as Stanford Linear Accelerator (SLAC) at that time which became fully operational in 1966. Taylor joined SLAC at that time leading some of the experiments using SLAC.

Taylor assembled two-storey tall spectrometer in SLAC capable of identifying particles and atoms based on their mass, momentum and energy and track their trajectories in the accelerator. After initial experiments elastic scattering of electron from atoms (in elastic scattering both incident particle and scattered particle have the same kinetic energy) which did not produce any new insights. The accelerator was then used to perform what is known as deep inelastic scattering, in which some of the energy of the incident electron beam bombarding atoms is transferred to the bigger particles, sometimes shattering them and the electrons are deflected. From the number of deflections by the electrons and the angles of their deflection scientists concluded that protons have internal structures. In the words of Persis Drell, former director of SLAC, protons are like 'jam with seeds' rather than 'a smooth jelly' a homogeneous mass of electrical charge known before. These seeds inside the protons are known as 'quarks'. It was Murray Gell-Mann, another Nobel Laureate, who gave the name 'quark'.The discovery of quarks paved the way for the development of Standard model, the classification system for all known elementary particles and forces.

According to one of his colleagues Taylor "would show up at 5 in the morning to take his shift and he would be there in the evening" when the lab director came around to check on progress. ❐

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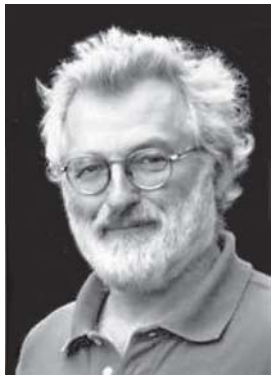
Nobel Winning Scientist John Sulston Passed Away at 75



John E. Sulston who won Nobel Prize in Physiology and Medicine in 2002 died of stomach cancer on March 6, 2018 at the age of 75. The Nobel he shared with two other colleagues Sydney Brenner and Robert Horvitz was "for their discoveries concerning genetic regulation of organic development and programmed cell death". Bending over the microscope for eight or more hours a day for years he observed the tiny transparent round worm *Caenorhabditis elegans* to understand how organisms develop. This worm was selected because it contains a few cells and easier to map every steps of its life cycle as they followed a program determined by their genes. By this way he was able to map all the 959 cells of the worm. After that he involved himself to map the worm's genes. Dr. Sulston and his colleagues broke the worm's DNA into 17,000 large random and overlapping pieces, characterized each piece by cutting into small fragments and then patched the pieces together. This was the beginning of the sequencing of the DNA that makes up the worm's genes.

Sulston was born on March 27, 1942 at Fulmer, Buckinghamshire, in England and obtained his Ph.D. degree in chemistry from the University of Cambridge in 1966. On obtaining his Ph.D. degree he moved to California to work with Leslie Orgel at the Salk Institute on molecular origin of life. Sulston returned to Cambridge on invitation received from Crick and joined Sydney Brenner at the Medical Research Council's Laboratory of Molecular Biology in the UK.

Sulston will be remembered also for his effort to create a centre to determine the sequence of the human genome with the help of National Institute of Health and Wellcome Trust in England. At his initiative the centre was named after Fredrick Sanger, who received two Nobel Prizes in chemistry, only second person with this distinction receiving Nobel in the same category twice (Bardeen was the other one in physics). He was against selling human genome sequence data produced in the laboratory. He was very candid in expressing his frustration in his Nobel lecture "It was not just the commercial bid itself that shocked, what was worse was that it gained support for all sorts of people for whom I'd previously had respect. I still don't exactly know why, but part of the reasons to be a business-style way in science now-a-days of following bandwagons and avoiding controversy in casethings turn out politically against you."

After the draft sequence was complete, Dr. Sulston left the science laboratory and determined to use his status as a Nobel laureate to speak up about "the sort of world we want." He took a position as the Chairman of the Institute of Science, Ethics and Innovation retiring in 2016. He was knighted in 2001, He wrote a book "The Common Thread: A Story of Science, Politics, Ethics and Human Genome" jointly with Georgina Ferry in 2002.

According to his co-winner of Nobel Dr. Horvitz, Dr. Sulston was an amazing scientist and a wonderful human being. ❐

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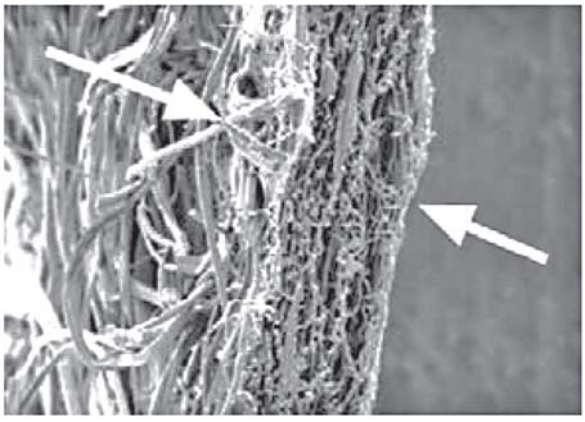
Silk Mats Developed to Treat Arthritis

Osteoarthritis, commonly known as wear-and-tear arthritis, is the most common type of arthritis. It is a condition in which the natural cushioning between joints – cartilage – wears away and makes the bones of the joints rub more closely against one another with less of the shockabsorbing benefits of cartilage. The rubbing results in pain, swelling, stiffness, and decreased ability to move. If left untreated, it can result in severe swelling, pain, and ultimately restrict the range of movement. Knee osteoarthritis is the most common bone and joint disease in India.

Current clinical treatment methods are limited by lack of viable tissue substitutes to aid the repair process. Replacement of the damaged knees with artificial knees is another option, but is quite expensive. Recently a team of researchers from Indian Institute of Technology Guwahati (IITG) and University College London, UK, led by Biman B. Mandal of IITG have developed a unique material based on Muga silk and bioactive glass fibres to treat osteoarthritis. According to the researchers, the synthesised mats can assist the growth of bone cells and repair worn-out joints in osteoarthritis arthritis patients (*ACS Applied Materials & Interfaces*, 9 February 2017 | DOI: 10.1021/acsami.6b16590).

In their effort to develop a suitable tissue substitute to repair the damaged tissue in osteoarthritis patients, the scientists looked into the natural bone-cartilage interface and tried to mimic it synthetically in lab conditions. Mandal said they used silk, a natural protein, to fabricate



Scanning electron micrograph of a cross-section of mats formed by electrospun bioactive glass layer (left arrow), followed by silk layer (right arrow), exhibiting coherent well-integrated interface.

electrospun mats to mimic the cartilage portion and bioactive glass to develop a composite material similar to the natural tissue. For the mat, the scientists used Muga silk easily available in North-east India which they said is "endowed with properties that enhance the healing process".

The researchers adopted a clean fabrication approach called electrospinning for developing the silk composite mats. Electrospinning is a fibre production method which uses electric force to draw charged threads of polymer solutions or polymer melts up to fibre diameters of the order of some hundred nanometres.

The process does not require the use of coagulation chemistry or high temperatures to produce solid threads from solution. This method makes the process clean by ensuring that no solvent can be carried over into the final product. According to Mandal, "It is similar to knitting, except that it utilises electric high voltage force to draw ultra-fine fibres." He said, a layer-by-layer approach was followed, where the bone layer was first formed, on top of which the cartilage layer was developed.

The resulting composite mat resembled the architecture of the natural bone-cartilage interface. The mats were tested under laboratory conditions, where artificial tissue formed efficiently during the two weeks of the study. When cultured with specific animal-derived immune cells, the mats did not induce any adverse immune responses, indicating biocompatibility. According to the researchers, the mats need to be tested in suitable animal models like rabbits and pigs, and finally in human trials, before they become available to patients.

To assist the regenerative process in osteoarthritis patients, the mats would be grafted in the damaged joint with cells harvested from the patient. "The mats would bond with the native tissue and act as an artificial tissue construct. Eventually the mats would degrade with time and new tissue formed in its place, repairing the damaged cartilage," Mandal said "The composite mats are a potential candidate as green materials to repair bone defects caused by osteoarthritis," he added. ❐

Biman Basu
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UV Radiation Key to Life's Origin

We know that life on Earth would not be possible without the Sun. Our nearest star not only provides light and heat but also causes the seasons, which make life thrive. But sunlight also has a dangerous component – ultraviolet (UV) radiation – that is extremely harmful for living beings. In fact, ultraviolet radiation is widely used to kill bacteria in water and for disinfecting materials and objects. Despite UV radiation being dangerous, however, life survives on Earth mainly because of a protective layer of ozone gas in Earth's upper atmosphere that cuts off the most dangerous ultraviolet radiation from the Sun.

Given this background, it may come as a surprise that the appearance of life on Earth was in fact triggered by UV radiation, as a new study shows. It was earlier believed that intense UV rays from a young Sun bombarded the early Earth and were thought likely to destroy any exposed organi molecules. But a new study by Sukrit Ranjan of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Mass USA, and colleagues suggests that UV radiation may have played a critical role in the emergence of life on Earth, and could be a key for where to look for life elsewhere in the universe. They contend that certain levels of UV might be necessary for the formation of ribonucleic acid (RNA), a molecule necessary for all forms of known life. The new study suggests that red dwarf stars – by far the most common sort of stars, and thought by some to be the best star systems in which to search for life – might not emit enough UV radiation to kickstart the biological processes most familiar to our planet (*The Astrophysical Journal*, 11 July 2017 | doi.org/10.3847/1538-4357/ aa773e).

According to the researchers, before life began, radiation from the Sun was the primary source of energy on our planet, just as it is today. In the oxygen-poor, prebiotic world, solar UV radiation may have provided the jolt to transform simple organic molecules into more complex ones, which were used as the building blocks of biology and life.

The earliest life on Earth is widely thought to have been based on RNA, the chemical cousin of DNA in which the sugar deoxyribose is replaced by ribose. RNA is made of subunits called nucleotides, which link together to form long polymer chains. According to the scientists, certain levels of UV might be necessary for the formation of ribonucleic acid, a molecule necessary for all forms of known life.

Planets of red dwarf stars like TRAPPIST-1 are unlikely to harbour life because it might not emit enough UV radiation to kick-start the biological *processes most familiar to our planet.*

"It would be like having a pile of wood and kindling and wanting to light a fire, but not having a match," says Ranjan. "Our research shows that the right amount of UV light might be one of the matches that gets life as we know it to ignite."

The CfA study was focussed on the study of red dwarf stars, which are smaller and less massive than the Sun, and the planets that orbit them. Recently, several planetary systems with potential habitable zones, where liquid water could exist, have been discovered around red dwarfs including Proxima Centauri, TRAPPIST-1, and LHS 1140, raising hopes of finding life there. But the recent study rules out such a possibility in view of insufficient UV intensity.

Using computer models and the known properties of red dwarfs, the authors estimate that the surface of rocky planets in the potentially habitable zones around red dwarfs would experience 100 to 1,000 times less of the UV radiation than the young Earth would have billions of years ago. Chemistry that depends on UV radiation might shut down at such low levels, and even if it does proceed, it could operate at a much slower rate than on the young Earth, possibly delaying the advent of life.

However, the study does not entirely rule out the possibility of life even if the UV output of a steady-state M-dwarf star is not sufficient to spark life, because transient elevated UV irradiation due to flares may be sufficient to trigger the process. Only further laboratory studies could establish whether such a possibility exists. ❐

Biman Basu
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Tropical Forests Become Net Emitters of Carbon Dioxide

For ages it had been assumed that tropical forests act as an enormous sink of carbon, removing substantial amounts of carbon dioxide during photosynthesis thus preventing uncontrolled rise in carbon dioxide level in the atmosphere. That is why conservation of forests has been given top priority to control global warming and climate change. Of course, forests absorb carbon dioxide only during the day; at night they release carbon dioxide. It has been estimated that every moment, the world's roughly 3 trillion trees either suck up carbon dioxide from the air or release it into the atmosphere. Scientists have been trying to quantify these carbon flows accurately in order to understand how forests help to regulate Earth's climate. Now, researchers have combined ground and satellite measurements of tropical Asia, Africa and the Americas and arrived at the surprising conclusion that tropical forests may be actually a net source of heat-trapping carbon emissions, rather than a carbon sink – they contribute more carbon dioxide to the atmosphere than they remove.

Wanton destruction and degradation of tropical forests have made them emit more carbon dioxide than they soak up.

The researchers led by Alessandro Baccini, a forest ecologist and remote sensing specialist at the Woods Hole Research Centre in Falmouth, Mass., USA, suggest that this may be due to the fact that tropical forests are drying out or being cleared, burned and logged so fast that they now spew out a lot more carbon than they trap by photosynthesis. According to them human activities such

as starting fires and natural factors including droughts have dealt a severe blow to forests' ability to store carbon. The study went further than any of the earlier studies in measuring the impact of disturbance and degradation, the thinning of tree density and the culling of biodiversity below an apparently protected canopy – usually as a result of selective logging, fire and drought (*Science*, 28 September 2017 | doi: 10.1126/science.aam5962).

The researchers based their finding on 12 years (2003-2014) of data and images from satellites including NASA's Ice, Cloud, and Land Elevation Satellite (*ICESat*), a laser-equipped satellite that gathered data on forest height and vegetation layers around the globe, and NASA's *Terra* and *Aqua* satellites. They also made use of laser remote sensing technology and field measurements.

Most of the carbon emissions from forests – making up nearly 70 percent in the tropics of the Americas, Asia and Africa – the study found are linked to forest degradation. In total, the researchers found, tropical forests emit 861 million tons of carbon to the atmosphere annually and absorb only 436 million tons of carbon each year, thus leading to a net contribution of 425 million tons to Earth's atmosphere each year, which is more than the emissions from all vehicular traffic in the United States.

According to the researchers, much of the carbon contribution is due to forest degradation, namely deforestation and the conversion of forests to urban spaces such as farms or roads. But more than two-thirds comes from a less visible source, namely a decline in the number and diversity of trees in remaining forests. ❐

Biman Basu
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Study Finds Pollution is Deadlier than War, Disaster, Hunger

There was a lot of hue and cry about air pollution in the National capital caused by Diwali crackers and the Supreme Court had to issue directive to curtail sale of crackers during Diwali. But Diwali crackers are not the only source of air pollution neither is air pollution the only health concern. Water, soil and noise pollution are also areas of concern. It has been revealed in a recent study by *The Lancet* Commission on pollution and health that pollution is deadlier than war, disaster, hunger. The study found that environmental pollution – from filthy air to contaminated water – is killing more people every year than all war and violence in the world; more than smoking, hunger or natural disasters; more than AIDS, tuberculosis and malaria combined. According to the study, "Diseases caused by pollution were responsible for an estimated 9 million premature deaths in 2015 16% of all deaths worldwide three times more deaths than from AIDS, tuberculosis, and malaria combined and 15 times more than from all wars and other forms of violence. The financial cost from pollution-related death, sickness and welfare, the study found, is equally massive, costing some $4.6 trillion in annual losses or about 6.2 percent of the global economy. *The Lancet* Commission study marks the first attempt to pull together data on disease and death caused by all forms of pollution combined.

Air pollution in Delhi. A recent study has found pollution to be a bigger killer than war, disaster, and hunger.

It is most often the world's poorest who suffer, the study found. The vast majority of pollution-related deaths – 92% " occur in low- or middle-income countries, "where policy makers are chiefly concerned with developing their economies, lifting people out of poverty and building basic infrastructure". Environmental regulations in those countries tend to be weaker, and industries lean on outdated technologies and dirtier fuels. In wealthier countries where overall pollution is not as rampant, it is still the poorest communities that are more often exposed, the study found.

The study attributed the present state of affairs to "decades of neglect of pollution and its harmful effects on people's health, the environment, and the planet both by governments and the international development community" (*The Lancet*, 19 October 2017 | http://dx.doi.org/10.1016/S0140-6736(17)32345-0).

The study found that one out of every four premature deaths in India in 2015, or some 2.5 million, can be attributed to pollution. Several other countries such Bangladesh, Pakistan, North Korea, South Sudan and Haiti also see nearly a fifth of their premature deaths caused by

pollution. China's environment was the second deadliest, with more than 1.8 million premature deaths, or one in five, blamed on pollution-related illness, the study found.

The report says India has taken some recent actions, such as tightening vehicle and factory emission standards and occasionally limiting the number of cars on New Delhi's roads. But they have done little about crop burning, garbage fires, construction dust or rampant use of the dirtiest fossil fuels.

It goes without saying that pollution mitigation and prevention can yield large net gains both for human health and the economy. Air quality improvements in the highincome countries have not only reduced deaths from cardiovascular and respiratory disease but have also yielded substantial economic gains. *The Lancet* study found that, in the US, an estimated US$30 in benefits has been returned to the economy for every dollar invested in air pollution control since 1970, which is an aggregate benefit of $1·5 trillion against an investment of $65 billion.

The aim of *The Lancet* Commission on pollution and health is to raise global awareness of pollution, end neglect of pollution-related diseases, and mobilise the resources and the political will needed to effectively confront pollution. To advance this aim, the Commission has come out with six recommendations: (1) Making pollution prevention a high priority nationally and internationally and integrate it into country and city planning processes; (2) Mobilising, increasing, and focussing the funding and the international technical support dedicated to pollution control;(3) Establishing systems to monitor pollution and its effects on health; (4) Building multi-sectoral partnerships for pollution control; (5) Integrating pollution mitigation into planning processes for noncommunicable diseases; and (6) Intensifying research on pollution and pollution control. ❐

Biman Basu
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